Working to Plant the Future

ASTROCULTURE™ Commercial Plant Growth Chamber

Ask almost any scientist if microgravity affects plants, and the answer will be yes. If you ask that scientist about specific effects, the answers will rapidly become, "It's hard to say." With only a few days or weeks of plant growth in orbit, many questions remain unanswered, including all the ways in which industry can take advantage of commercial microgravity plant growth research.

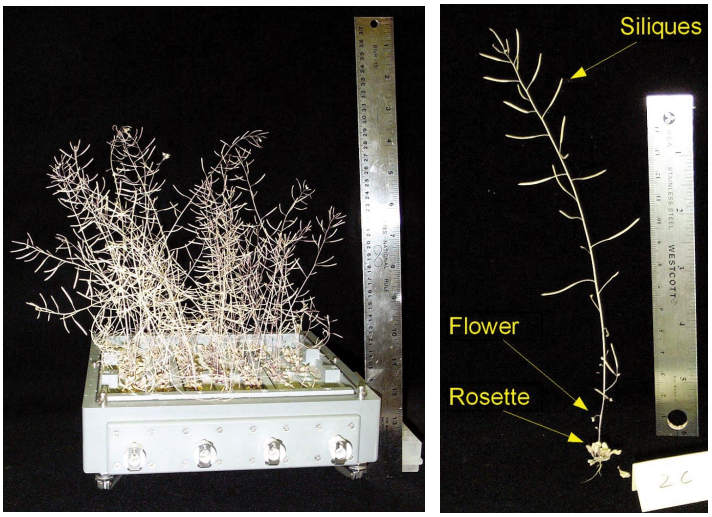
The advantages have already been proven. The commercial plant investigations on STS–107 are the result of previous research done in microgravity. These investigations seek to expand the possibilities and answer questions raised during previous research.

The development of new crops is being enhanced through commercial microgravity research.

Any gambler will tell you that odds of 1 in a 1,000, or worse, are not a good bet. Yet, according to Dr. Rick Vierling, President of Producers' Natural Processing (PNP), Inc., those are the odds facing researchers trying to transfer desirable genes into food and other important crops. PNP is one of the commercial sponsors for the gene transfer research. Instead of older methods, such as cross pollination and back-crossing regeneration that can take years to produce results, researchers now use bacteria to transfer the gene carrying the desired traits to seedlings. These seedlings can, in turn, allow subsequent generations of the crops to stably inherit the trait. In Earth-based laboratories, however, the expected success rate for this process is at best 1 plant in 1,000, or 0.1 percent.

Commercial Space Center: Wisconsin Center for Space Automation and Robotics (WCSAR) at University of Wisconsin-Madison
Director: Dr. Weijia Zhou

Previous commercial research on STS–95 and STS–101 has clearly shown that doing the transfer in microgravity can greatly improve the success rate. Learning how to best do this so that optimal results are achieved, however, requires more research. The increased effectiveness is due at least in part to the fact that microbes, such as the bacteria used to transfer the desired trait, thrive in microgravity. Learning how to control that bacteria such that it can do its job without harming the seedlings, and learning how to prevent other microbes from harming them at the same time, requires further research.



Arabidopsis plants (left) in the root tray retrieved from the STS–104 mission. Representative single *Arabidopsis* plant (right).

There will be two flight elements on this mission, the ASTROCULTURE™ glovebox and the ASTROCULTURE™ plant growth unit. Investigators from the commercial sectors will once again validate the microgravity impact on soybean transformation, and further improve the ASTROCULTURE™ glovebox (ASC-GB) and transformation protocol. The new transformation technology to be used on STS–107 will hopefully provide benchmark information for future development of a space-based, commercial gene transfer system.

Background Information

Science

Both commercial investigations on STS–107 are being done in partnership with the Wisconsin Center for Space Automation and Robotics (WCSAR) at the University of Wisconsin-Madison, one of the NASA Commercial Space Centers. WCSAR is a primary center for commercial agribusiness research in microgravity, and has developed ASTROCULTURE™ commercial plant growth research hardware.

The ASTROCULTURE™ commercial plant growth research chamber provides a completely self-contained system for growing plants that includes lighting, temperature control, atmospheric control, nutrient delivery, and more. It can be modified to accommodate specific commercial requirements, such as the inclusion of proprietary hardware on the STS-95 mission that allowed International Flavors & Fragrances (IFF) to sample the essential oils that are produced by the rose. This versatile hardware is being prepared for use on the *International Space Station*.

Flight Hardware

The ASTROCULTURE™ plant growth chamber (ASC-GC), developed in the early 90s, is a single middeck locker insert spaceflight payload. The purpose of the ASC-GC unit is to verify the capability and reliability of the various subsystems that can provide an enclosed, environmentally controlled plant growth chamber to support short-term (average of 30 days) commercial or fundamental plant research in microgravity. ASC-GC, designed to operate autonomously, provides temperature control, humidity control, lighting control, nutrient delivery, atmospheric control and video/data downlink. ASC-GC can be configured with a single chamber or dual chambers in which the environmental conditions for each chamber are independently controlled.

The ASTROCULTURE™ plant growth unit (ASC-GC).

Early Results

IFF returns as an Industry Partner on this mission. Many were captivated during the historic STS–95 mission by pictures of a miniature rose plant growing in the ASTROCULTURE™ commercial plant growth chamber. The rose was flown to see if the microgravity environment would alter the fragrance of the rose — something very important to the multibillion dollar a year flavors and fragrance industry. According to IFF, the results were literally out of this world.

Commercial experiments in microgravity with this miniature rose have led to the discovery of a new and unique fragrance of great importance to the perfume industry.

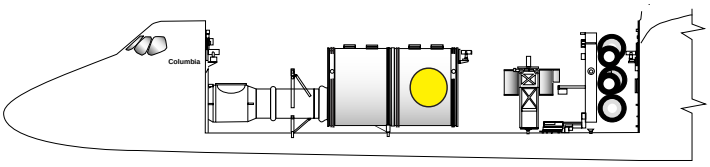
"The development of this entirely new and unique space rose and its first commercial use in a fine fragrance sets a precedent in the fragrance industry and opens the door to the discovery of similar unknown aroma molecules," said Richard A. Goldstein, IFF's Chairman and Chief Executive Officer. Dr. Braja Mookherjee, Vice President and Director of Natural Products Research states, "This transformation has created a completely new fragrance that is not of this Earth. IFF intends to further explore space research on living plant materials to benefit mankind."

The investigation on STS–107 is a part of that further exploration and seeks to try and duplicate the commercial success of the STS–95 research. The new scent from the "Overnight Scentsation" rose has already had a commercial impact, being used in the revamped Zen perfume by Shiseido.

Zen perfume.

"We are pleased that IFF was able to create an entirely new fragrance ingredient based on findings using our technologies, and that such research will ultimately translate into new commercial products," states Dr. Weijia Zhou, Director of WCSAR. "This experiment demonstrates a successful collaboration between a commercial entity and the NASA-sponsored Commercial Space Center. We are even more pleased that IFF is going to conduct another investigation with us this mission. This is a strong illustration of how commerce can benefit from space-based research."

"We are also pleased with the outcomes obtained from the second gene transfer experiment conducted during STS–101. WCSAR and its commercial partner are developing a more robust and effective system to enhance the transformation efficiency and stability. This improved system will be used to conduct a third commercial gene transfer experiment on STS–107."



Approximate location of this payload aboard STS–107.